HMA Construction Program

Compaction

Learning Objectives

1. State the objective of compaction
2. Describe five engineering properties related to compaction
3. Identify material and mix properties affecting compaction
4. Describe the types of compaction equipment

Learning Objectives

5. Describe the considerations in the selection of compaction equipment
6. Identify compaction variables
7. Identify the main components of compaction equipment maintenance
8. Describe proper compaction operating procedures

Definitions

- Density
- Pass
- Coverage

Importance of Compaction

- Improve Mechanical Stability
- Improve Resistance to Permanent Deformation
- Reduce Moisture/Air Penetration
- Improve Fatigue Resistance

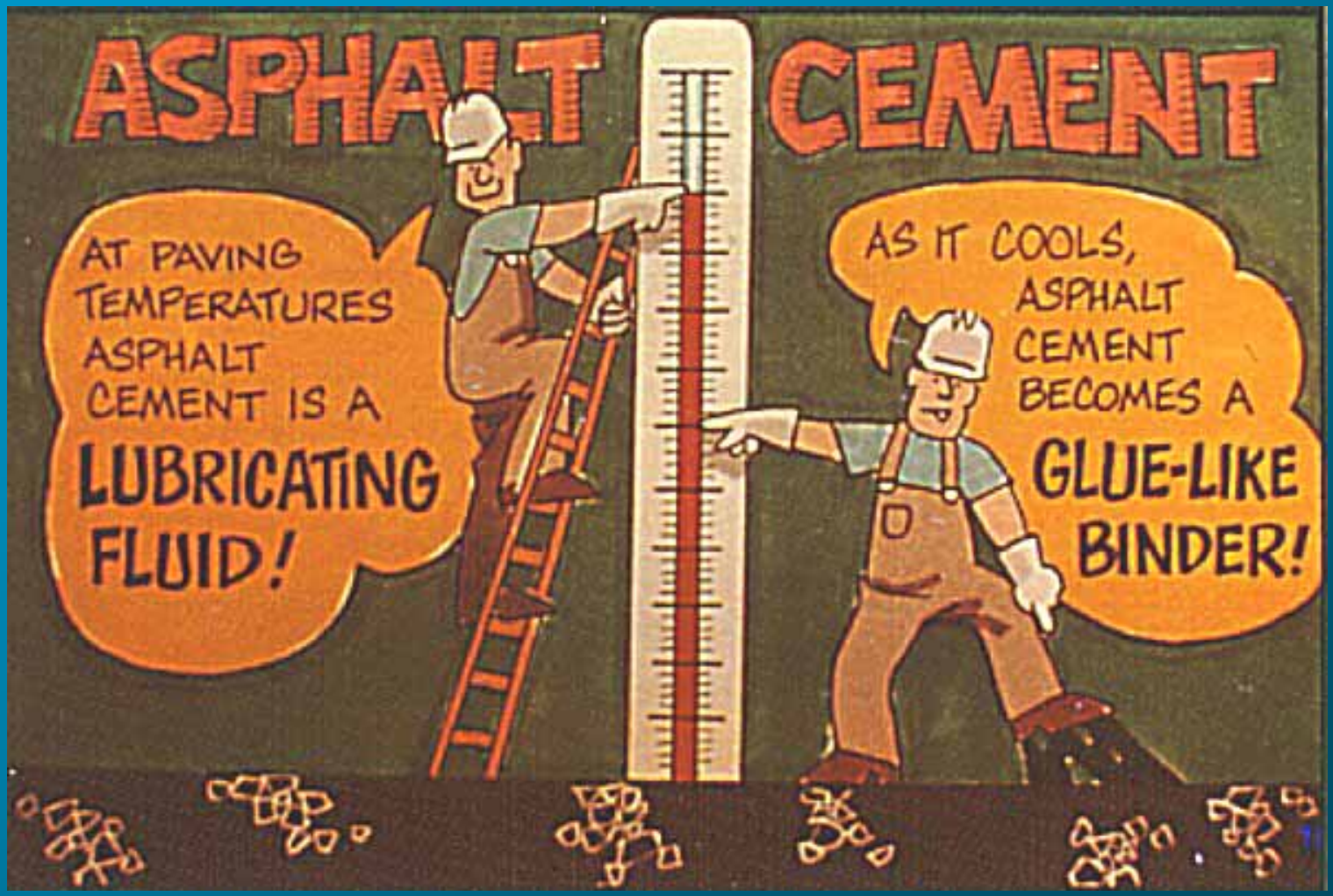
Factors Affecting Compaction

- Properties of the Materials
- Environmental Variables
- Laydown Site Conditions

Properties of the Materials

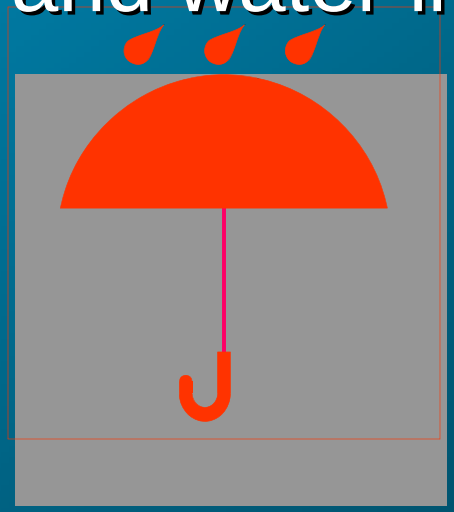
- Aggregate
- Asphalt Cement
- Mix Properties

Courtesy of Caterpillar Paving Products


ASPHALT CEMENT
AT PAVING TEMPERATURES ASPHALT CEMENT IS A LUBRICATING FLUID!
AS IT COOLS, ASPHALT CEMENT BECOMES A GLUE-LIKE BINDER!

Binder and Compaction

- Asphalt binder holds particles together
  - Provides lubrication at high temperatures
  - Provides cohesion at in-service temperatures
- Prevents air and water intrusion into mat



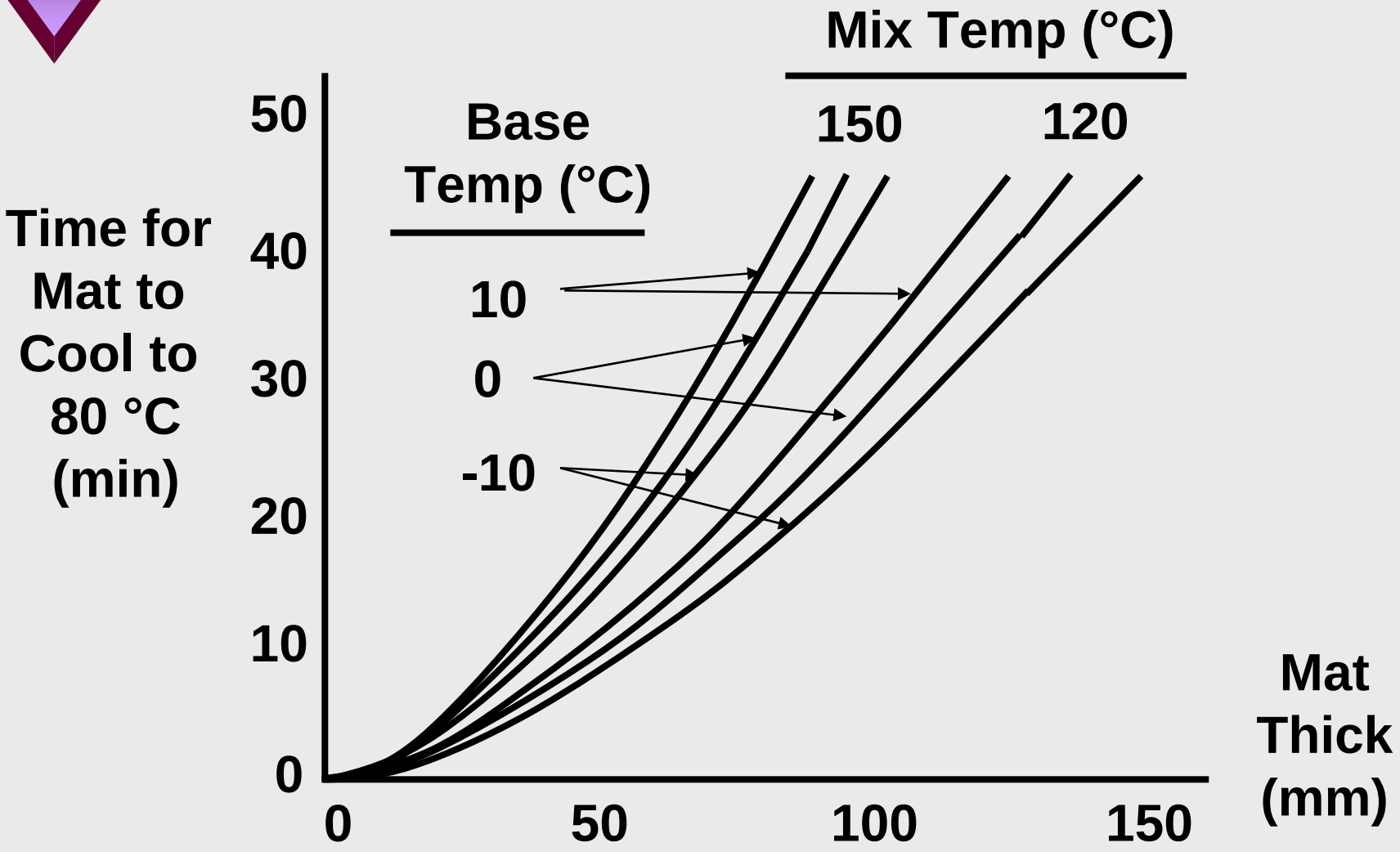
Mat after Compaction

- 4%-8% theoretical air voids allow for needed expansion
- Aggregates moved closer together
- Provides cohesion, impermeability, and stability

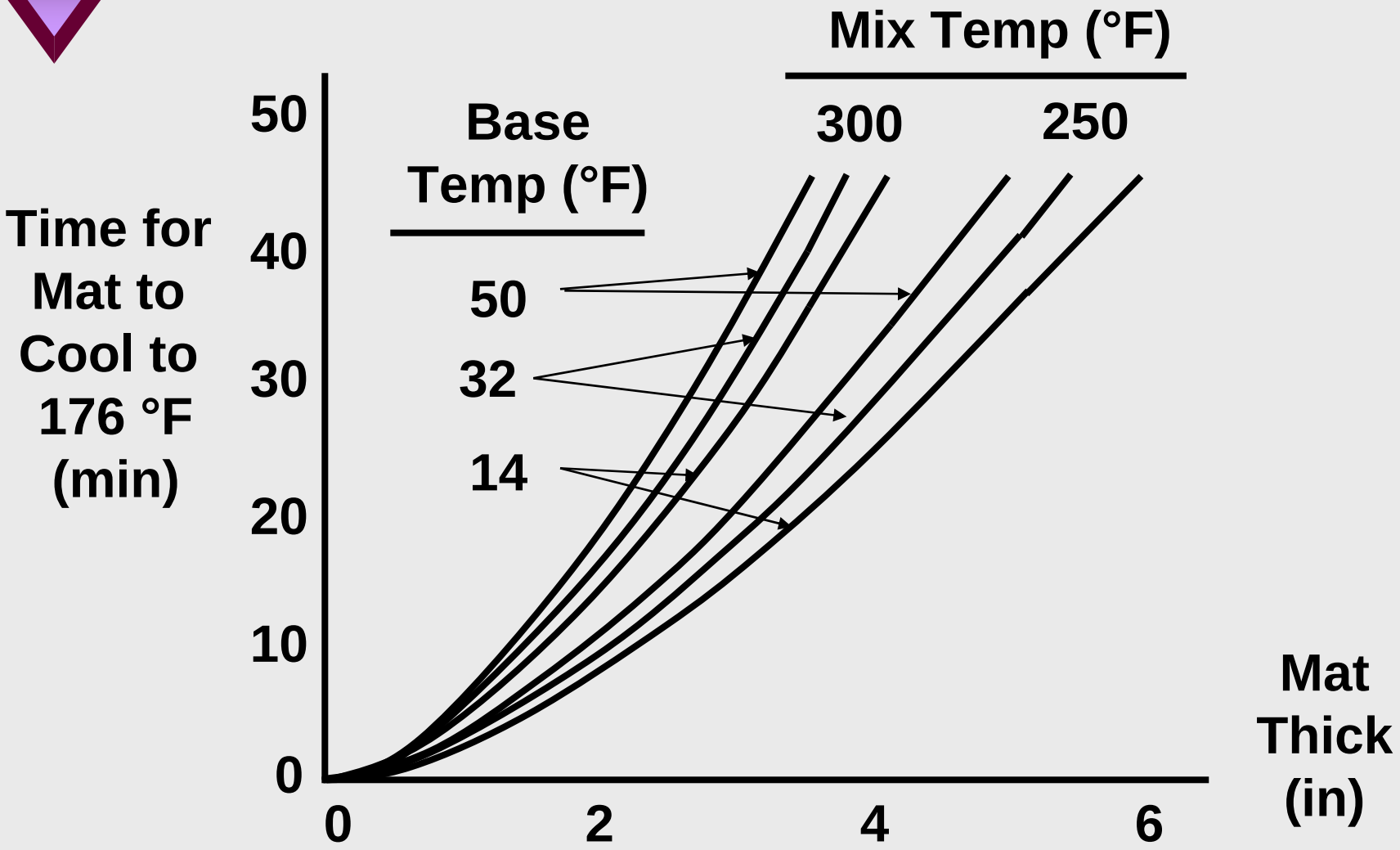
Rate of Cooling Variables

- Layer Thickness
- Air Temperature
- Base Temperature
- Mix Laydown Temperature
- Wind Velocity
- Solar Flux

Mat Temperature Loss

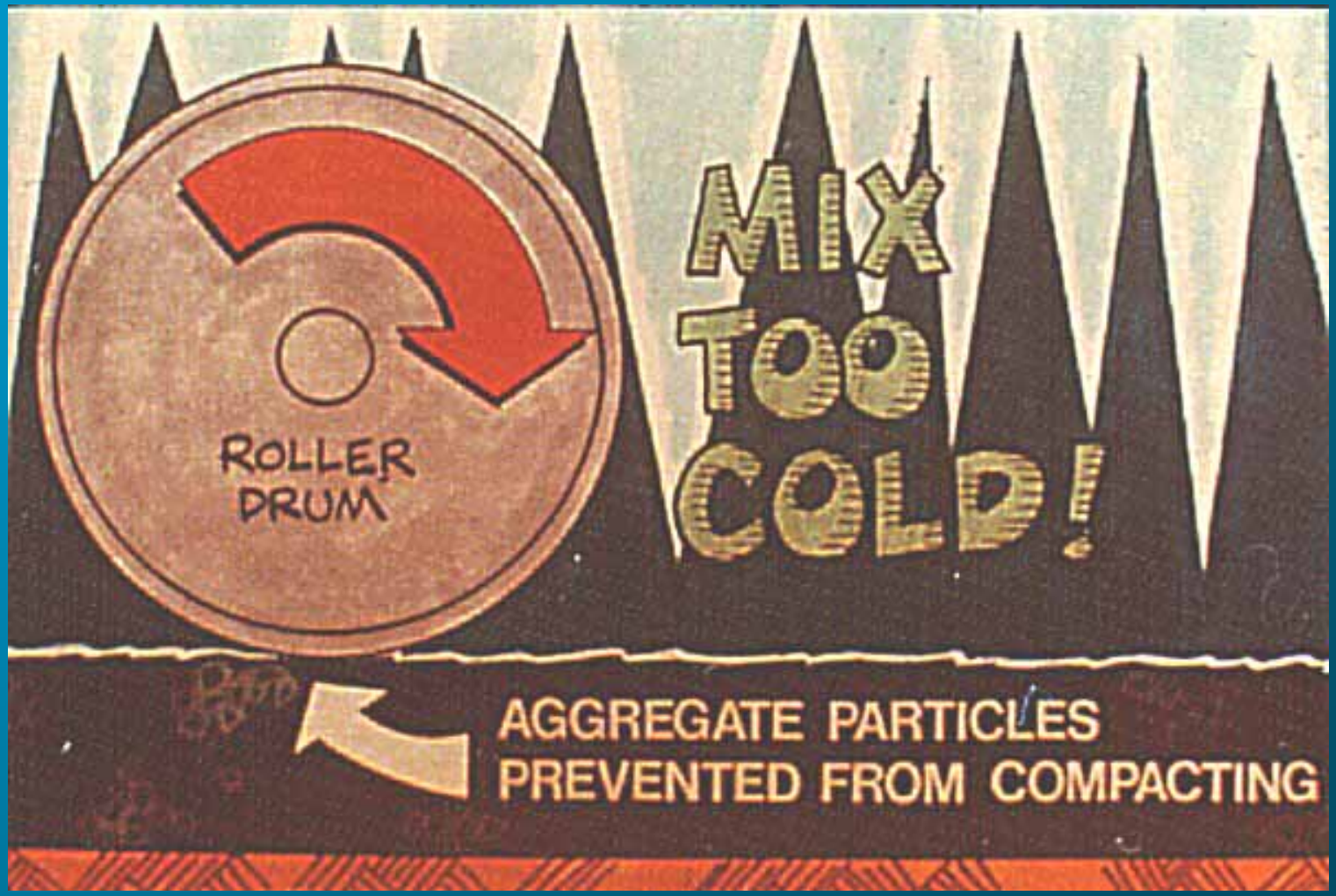


Mat Temperature Loss



Major Factors Affecting Rolling Time

FACTORS	allows MORE time	allows LESS time
Mat Thickness	THICK	THIN
Mix Temperature	HIGH	LOW
Base Temperature	HIGH	LOW

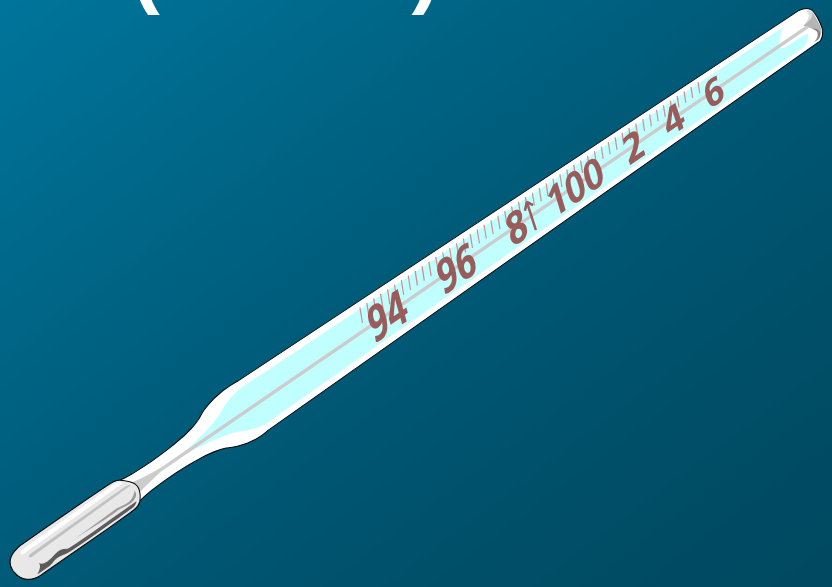

ROLLER
DRUM
MIX
TOO
COLD!
AGGREGATE PARTICLES
PREVENTED FROM COMPACTING


MIX TOO HOT!
ROLLER
DRUM

Typical Compaction Temperature Range

85 °C (185 °F) - 150 °C (300 °F)

What are Yours?



Types of Rollers

- Static Steel Wheel
- Pneumatic – Rubber Tired
- Vibratory

CAT

Courtesy of Caterpillar Paving Products

Static Steel Wheel Roller

- Contact Pressure
- Operation

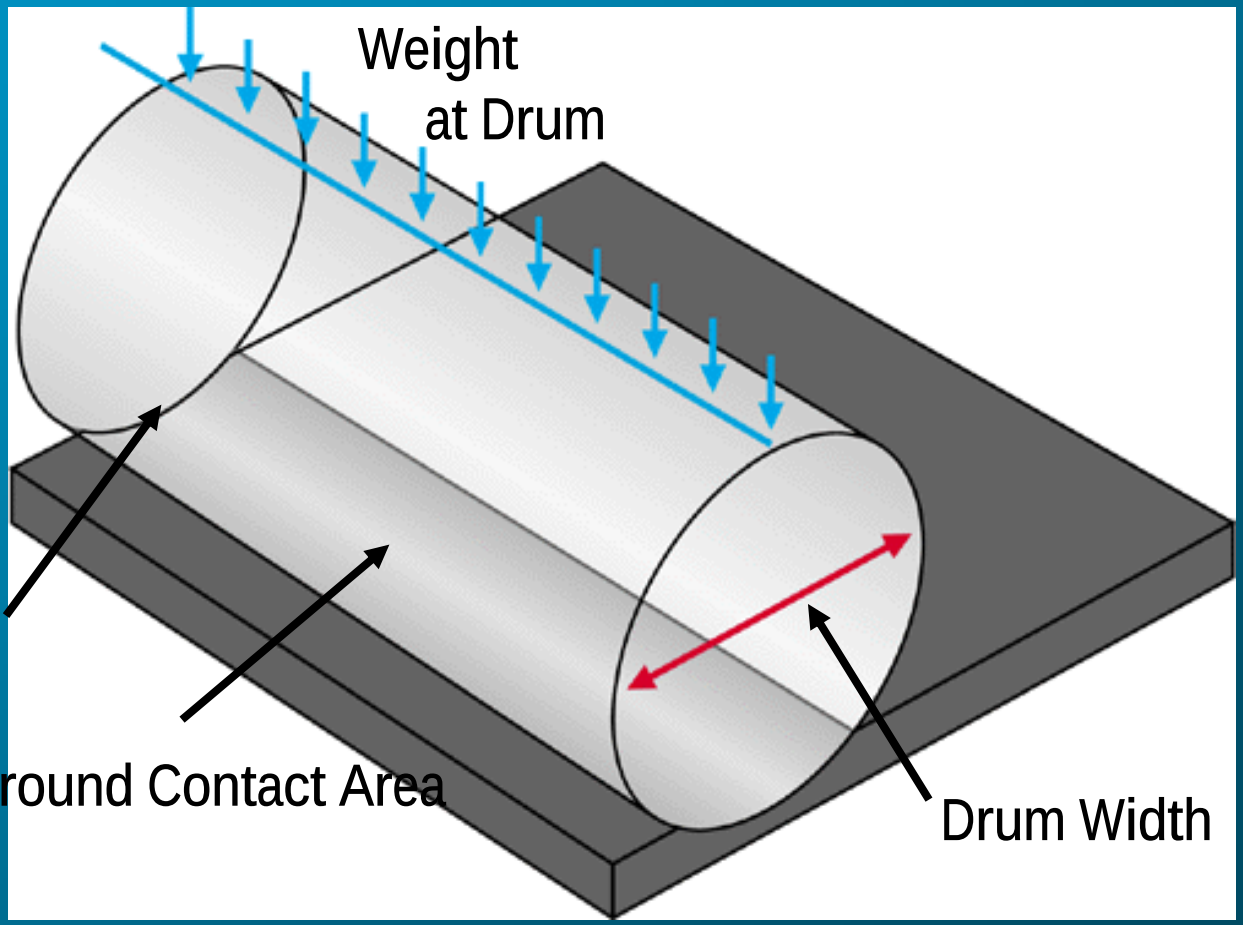
Static Steel Wheel Roller

UNITS

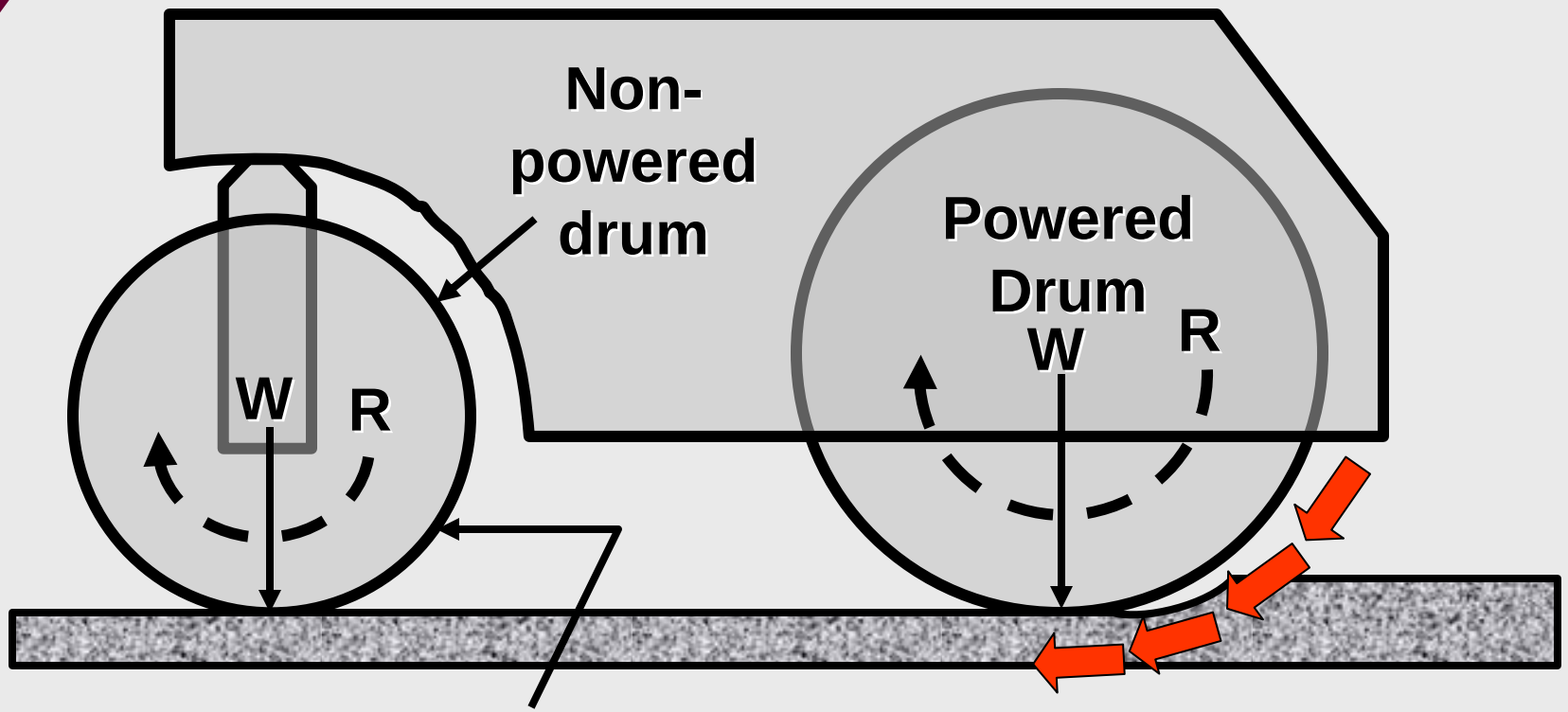
Kilograms Per
Linear Millimeter
(kg/mm)

Pounds Per Linear Inch
(lb/in)

Contact Pressure



Travel



Frictional force
turns trailing drum

Roller Contact Pressure

Roller Contact Pressure at Varying Penetration Depths for 12 ton Static Roller

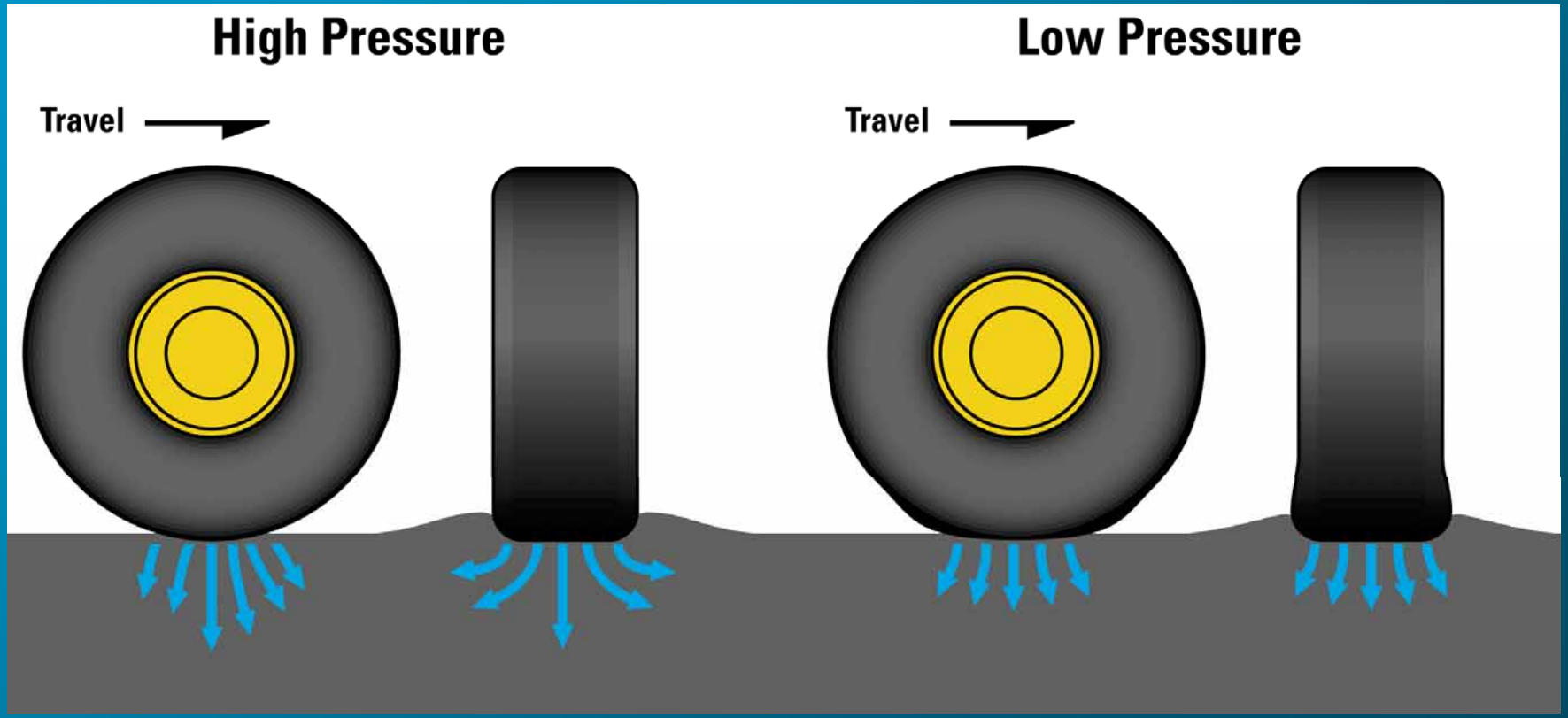
Penetration Depth (in)	3/4”	1/2”	1/8”	1/16”
Contact Pressure (psi)	36	46	88	132

Pneumatic Tired Rollers

- Wheel load
- Tire design
- Inflation pressure
- Contact area

Pneumatic

Tire Inflation Pressure Versus Ground Contact Pressure

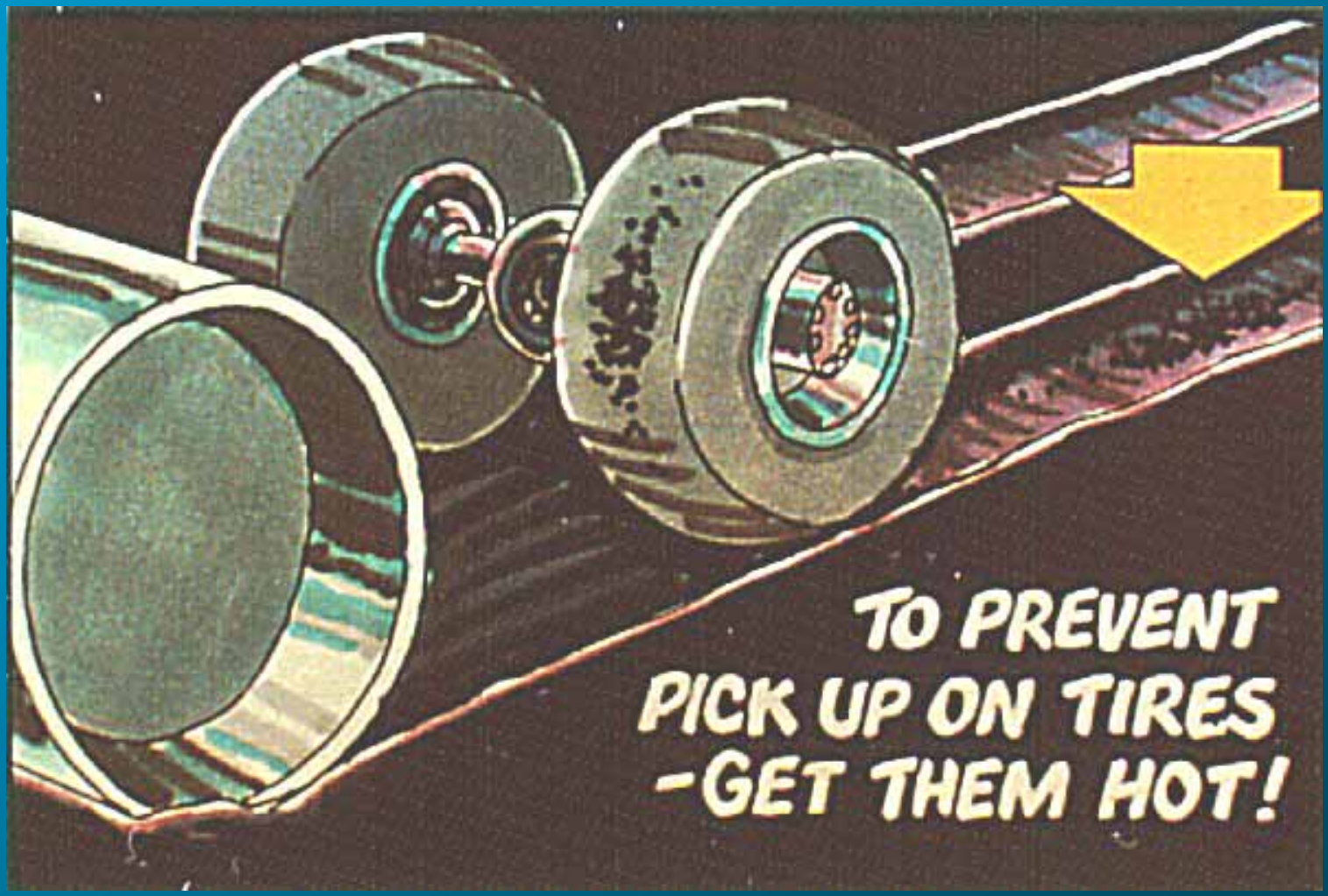


Courtesy of Caterpillar Paving Products

Inflation Pressure and Ground Contact Pressure at Various Wheel Loads and Ply Ratings

Example	Ply Rating	Wheel Load lb	Tire Pressure psi	Contact Area in^2	Ground Contact Pressure psi
A	14	1,250	130	16	78
	14	2,800	130	30	92
B	14	2,300	35	41	56
	14	2,300	130	26	88
C	10	2,800	90	38	73
	14	2,800	130	30	92

Tire Pickup



Skirted Pneumatic Roller

Tire Pick Up

Pneumatic Roller Operation

Vibratory Rollers

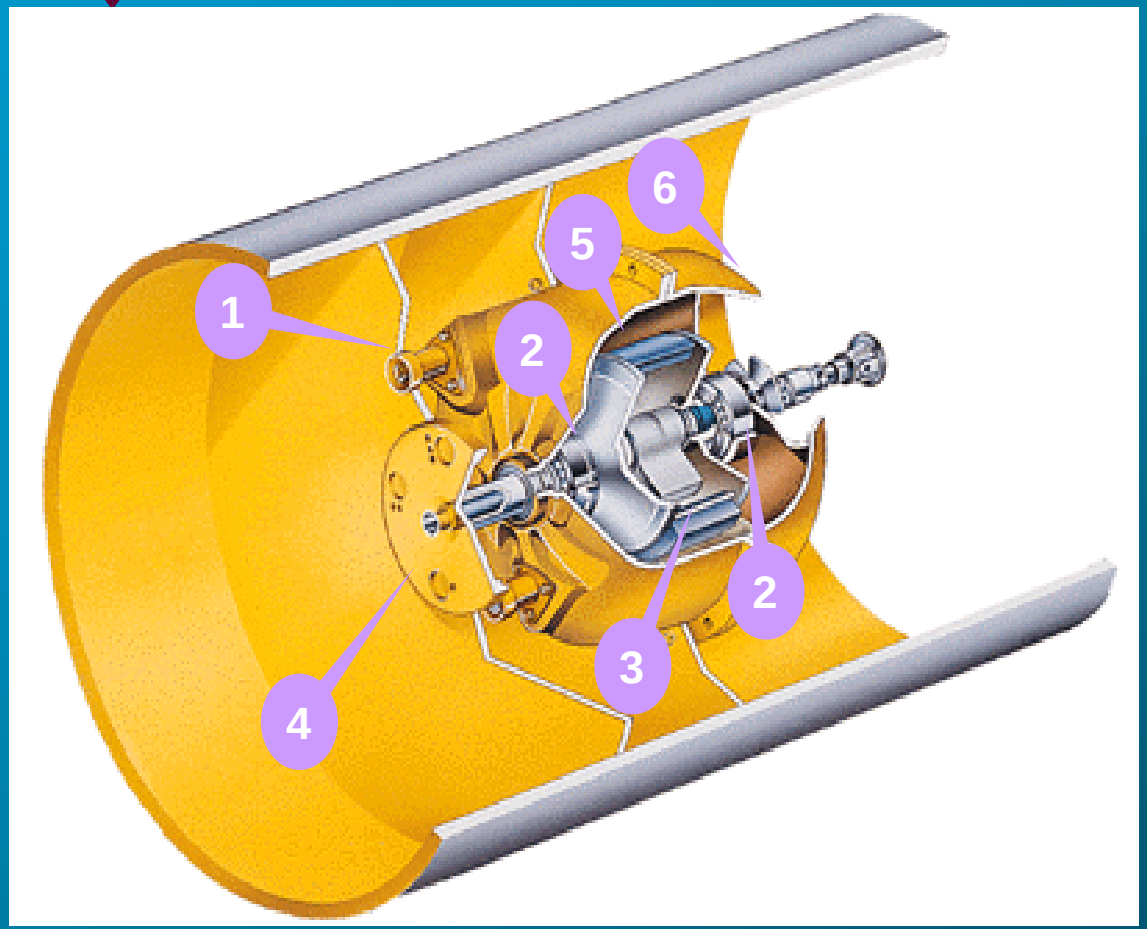
- Amplitude
- Frequency
- Impact Spacing
- Operation

Single Articulated Frame

Double Articulated Frame

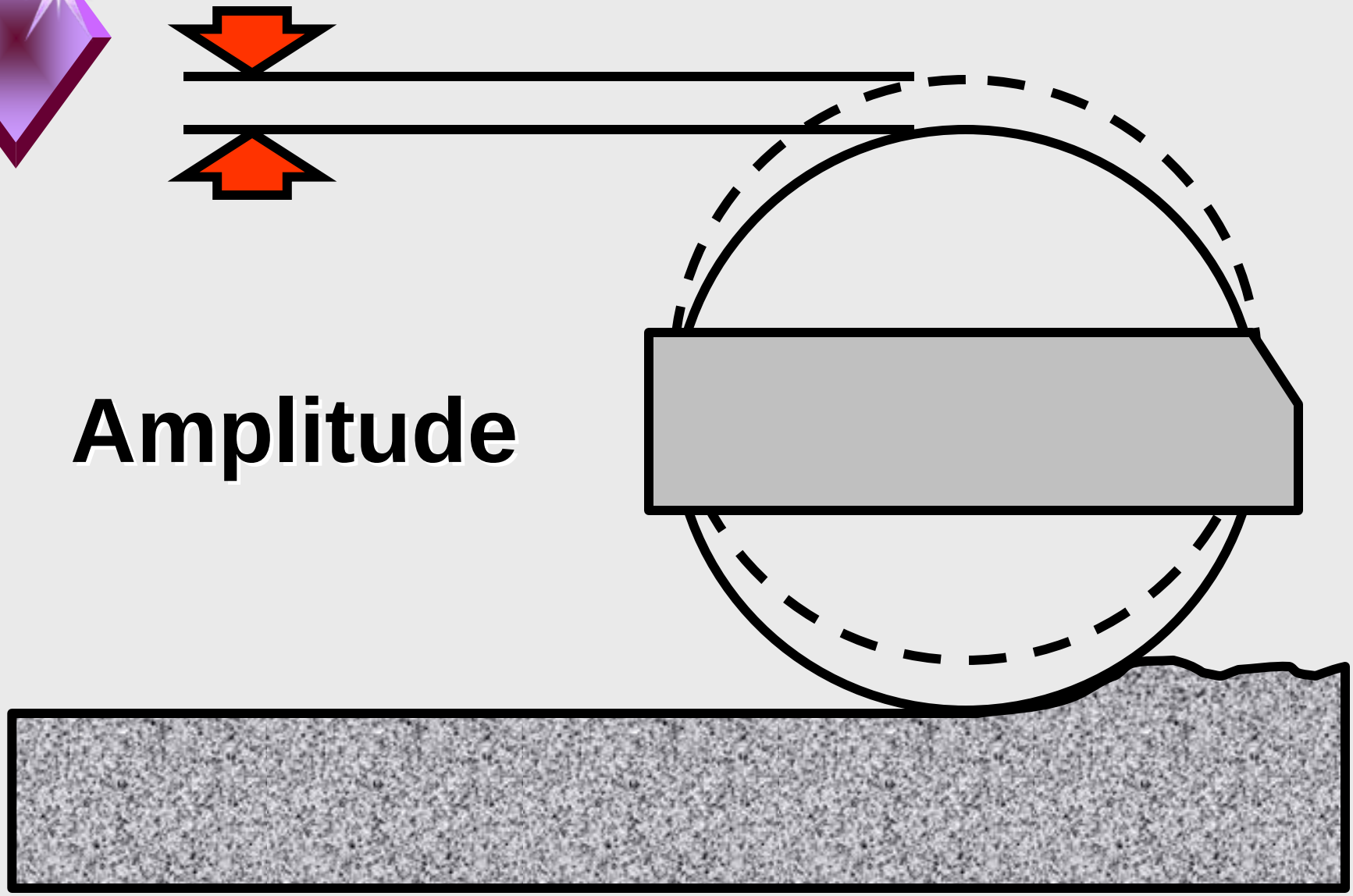
Vibratory Roller

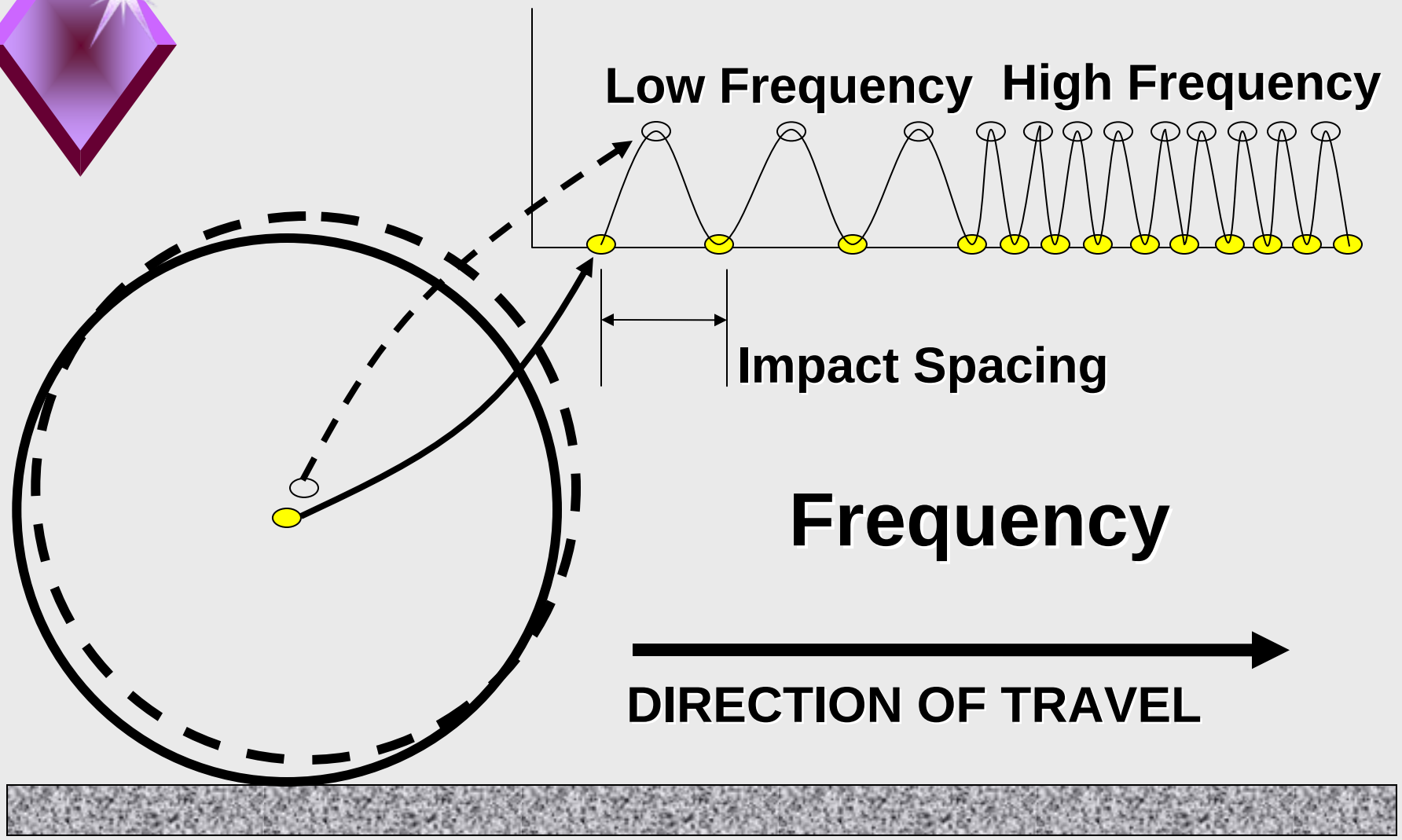
Eccentric Weight System



1. Oil level sight gauge
2. Eccentric weight shaft bearings
3. Three-position counterweight
4. Amplitude selection wheel
5. Fixed eccentric weight
6. Pod-style housing

Amplitude



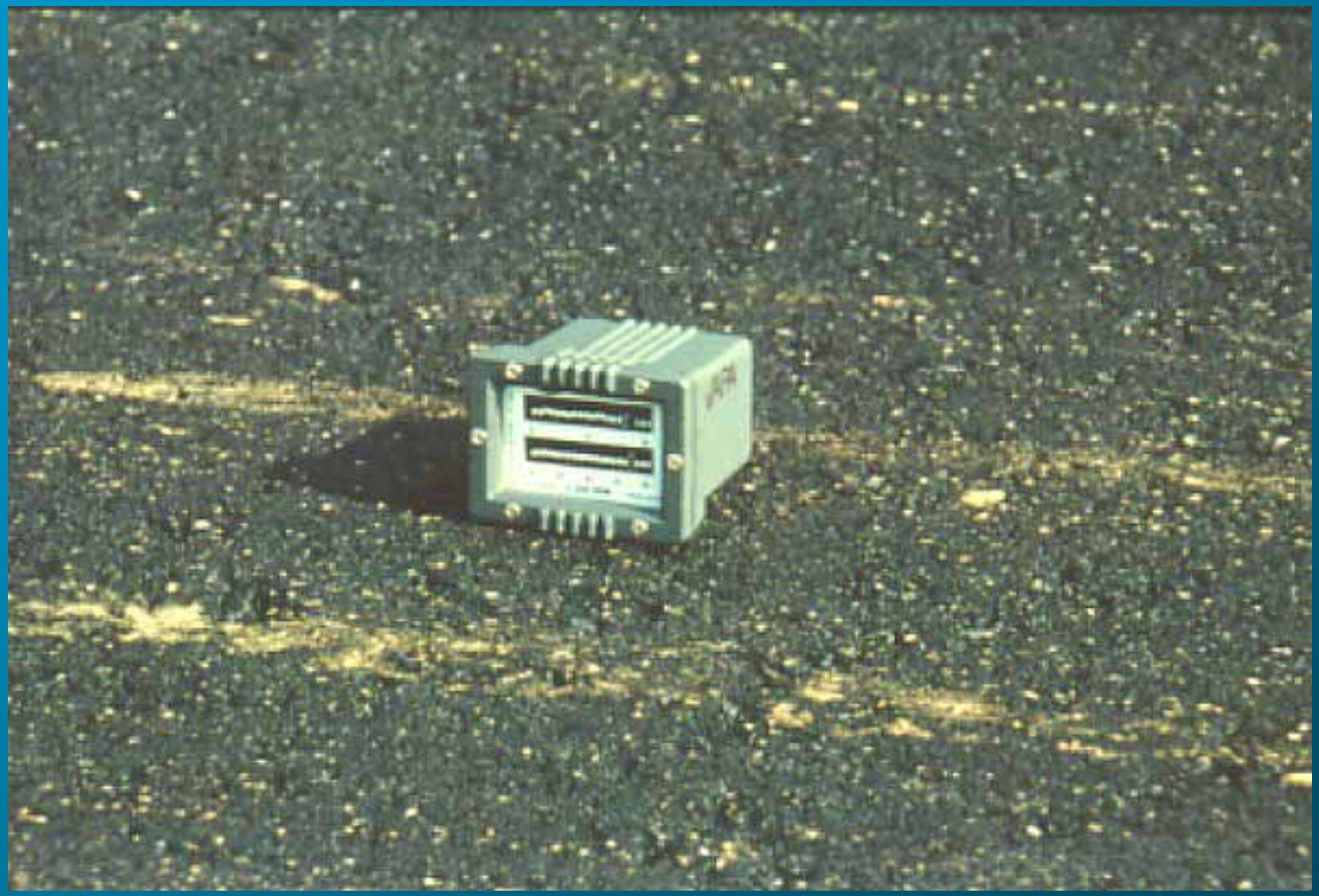

Low Frequency
High Frequency
Impact Spacing
Frequency
DIRECTION OF TRAVEL

Typical Data for Vibratory Tandem Rollers

Vibratory Steel Tandem ton	Oper. Wt. lb	Drum Diam. ft	Drum Width ft	Static Drum lb/in	Dynamic Drum lb/in	VPM	Nom. Amp. in
6.0-8.0	14,700	3.6	4.6	130	260	2,900	0.025
9.5-11.0	20,500	3.9	5.6	158	384	2,600	0.03
> 13.0	30,000	4.9	6.9	186	423	2,400	0.03

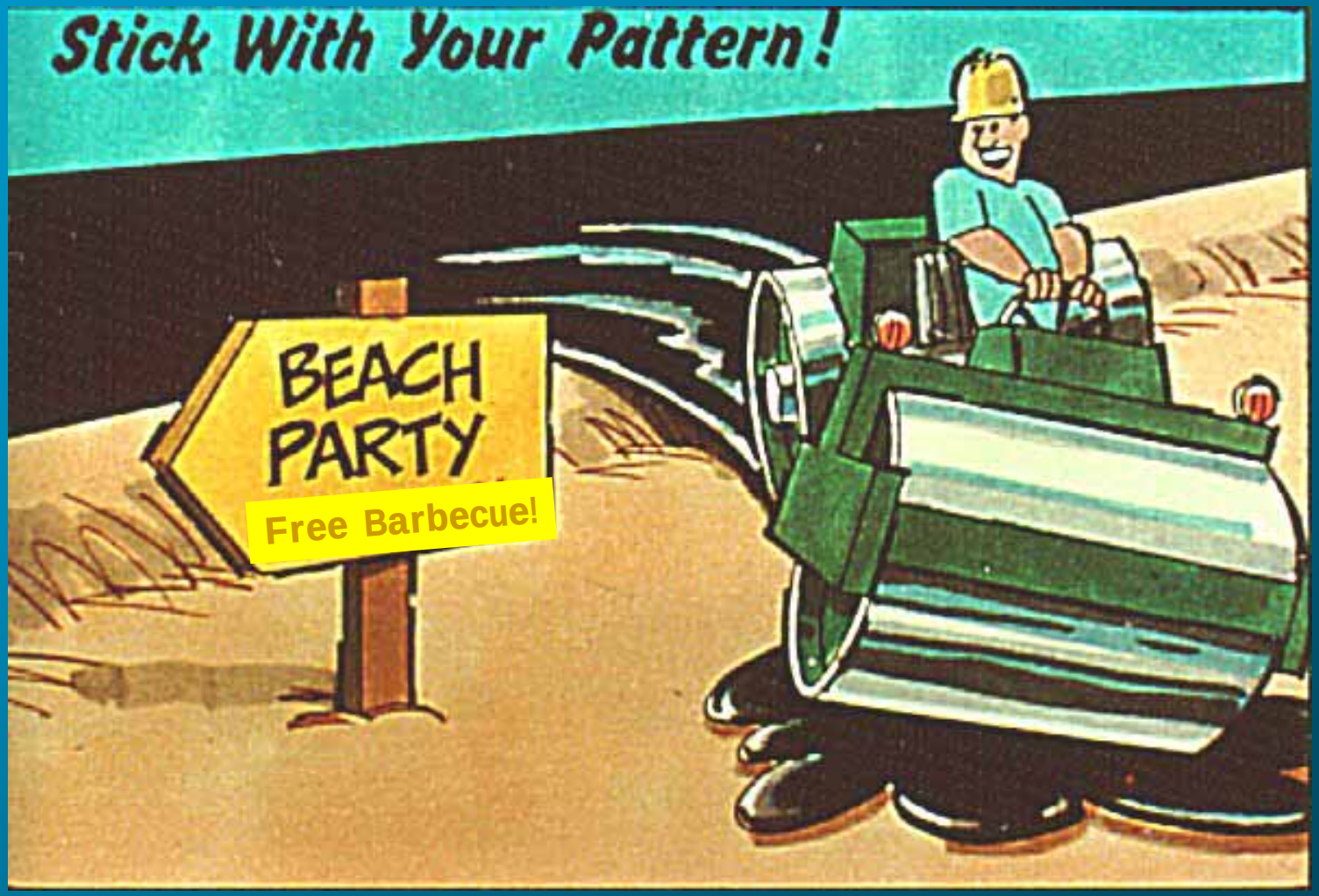
Improper Impact Spacing

Reed Tachometer



Vibratory Roller Operation

Stopping


Stick With Your Pattern!
BEACH PARTY
Free Barbecue!

Water Spray Bar

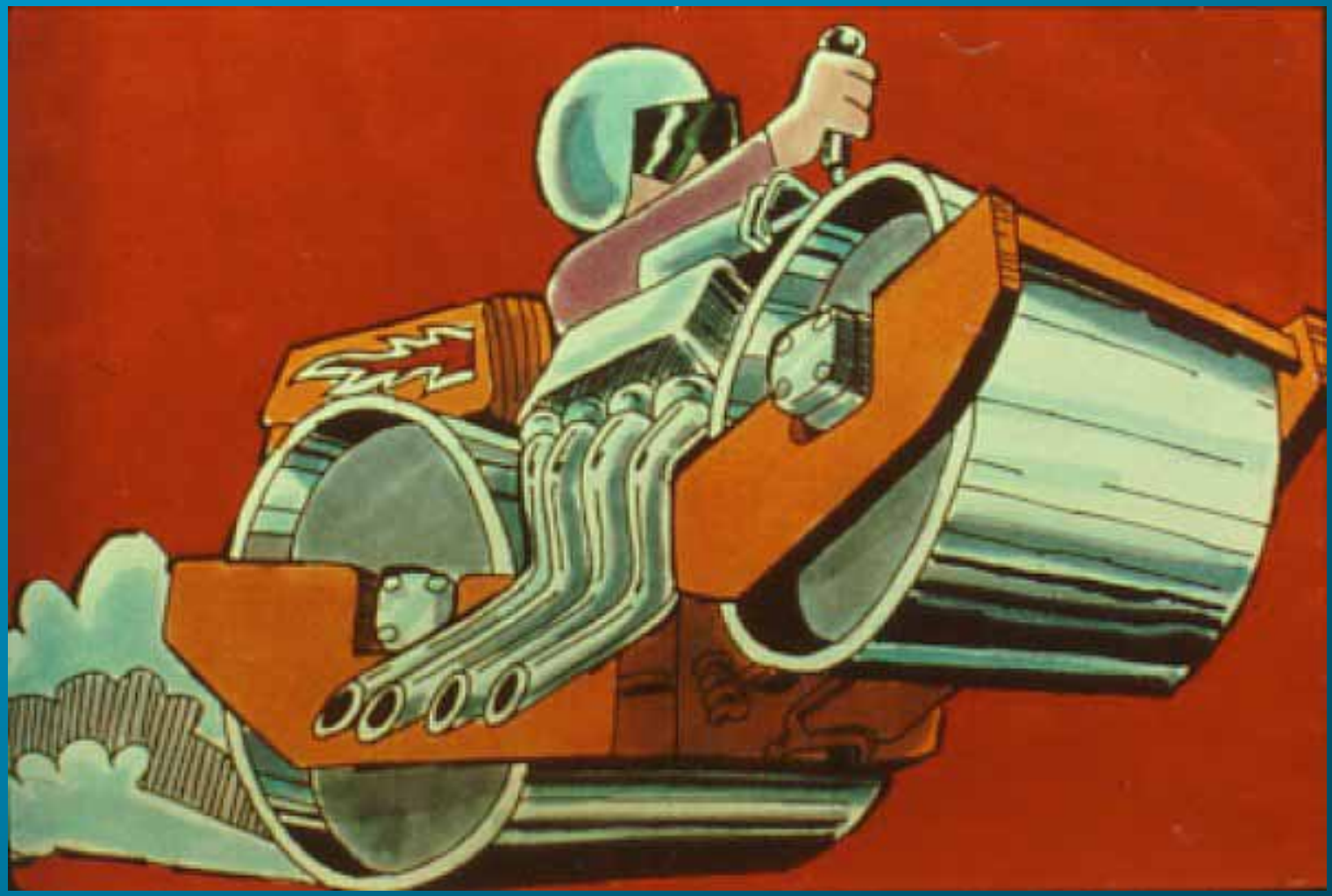
Pads

Poor Maintenance

Compaction Variables

- Roller Speed (Dwell Time)
- Number of Coverages
- Rolling Zone
- Rolling Pattern

Speed



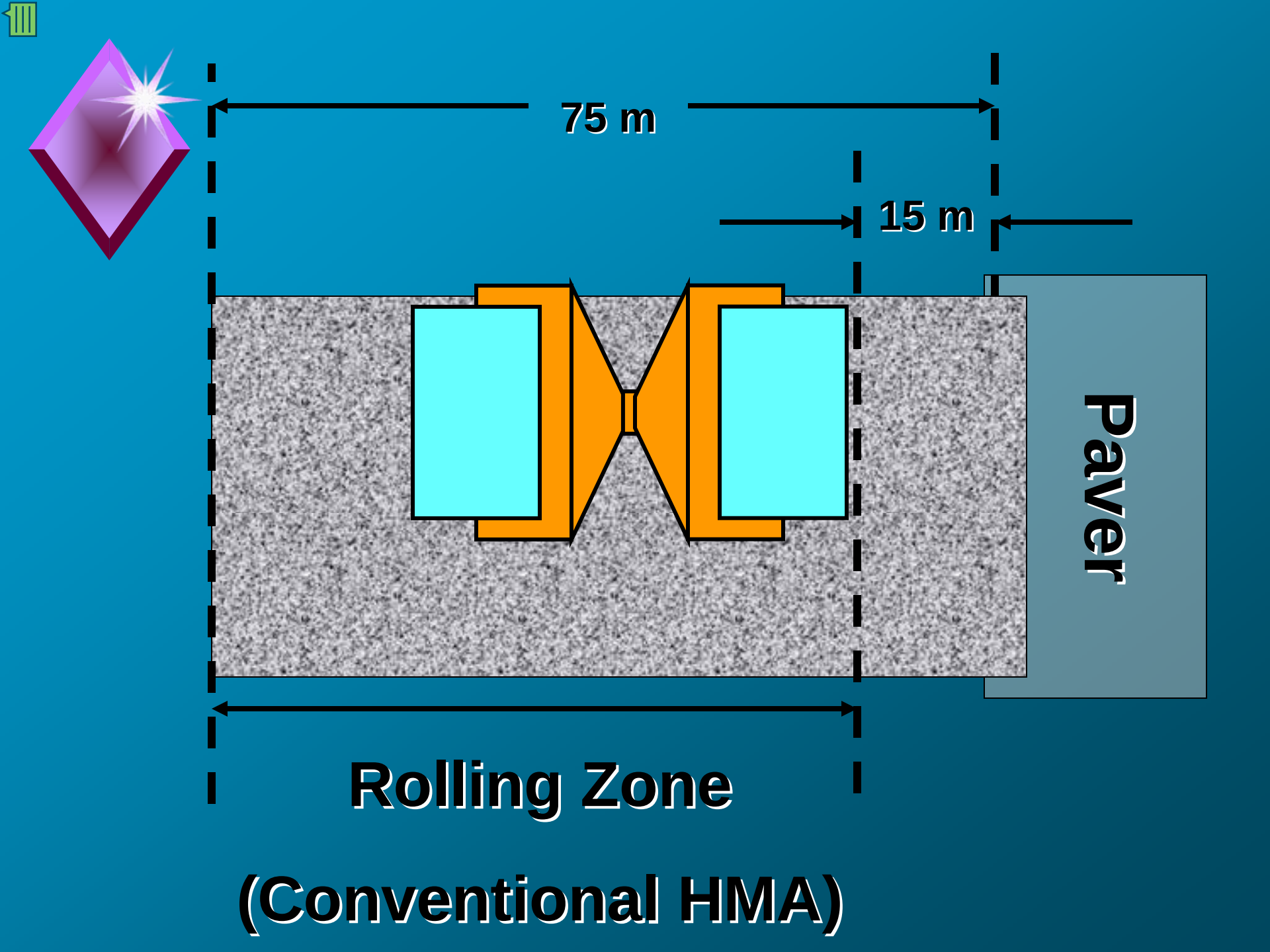
Typical Range of Roller Speeds (mi/hour)

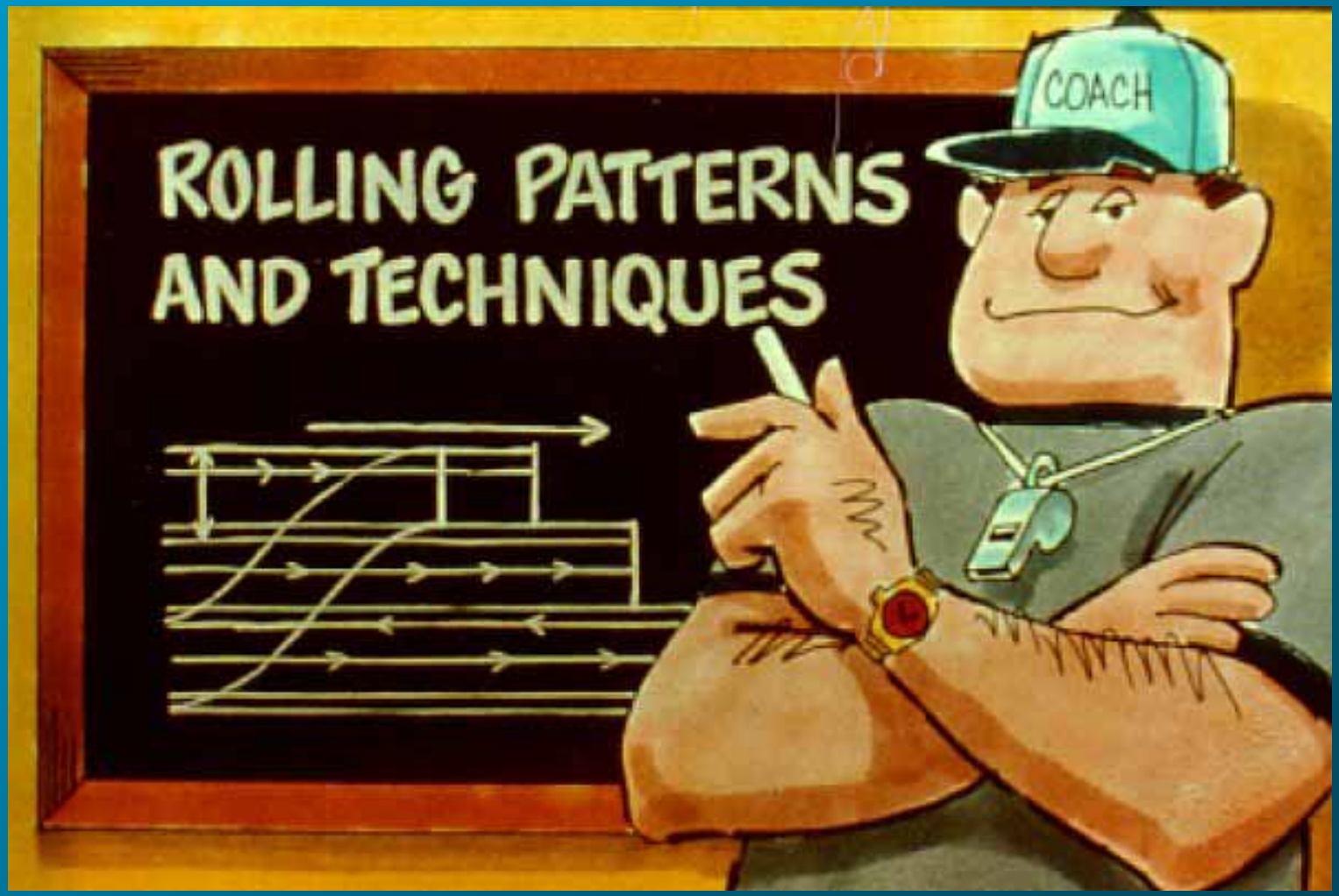
Type of Roller	Breakdown	Intermediate	Finish
Static Steel Wheel	2.0 to 3.5	2.5 to 4	3.0 to 5.0
Pneumatic	2.0 to 3.5	2.5 to 6.4	4.0 to 7.0
Vibratory	2.0 to 3.0	2.5 to 3.5	-------

One Coverage

Each time the roller goes over a specific point is ONE PASS.

How many passes of the roller are needed to cover the width of the mat one time ?


75 m
15 m
Paver
Rolling Zone
(Conventional HMA)


ROLLING PATTERNS
AND TECHNIQUES
COACH

Test Strip Construction

- Simulating Actual Conditions
- Establishing Roller Patterns
- Calculating Effective Roller Speed

Establishing Roller Pattern

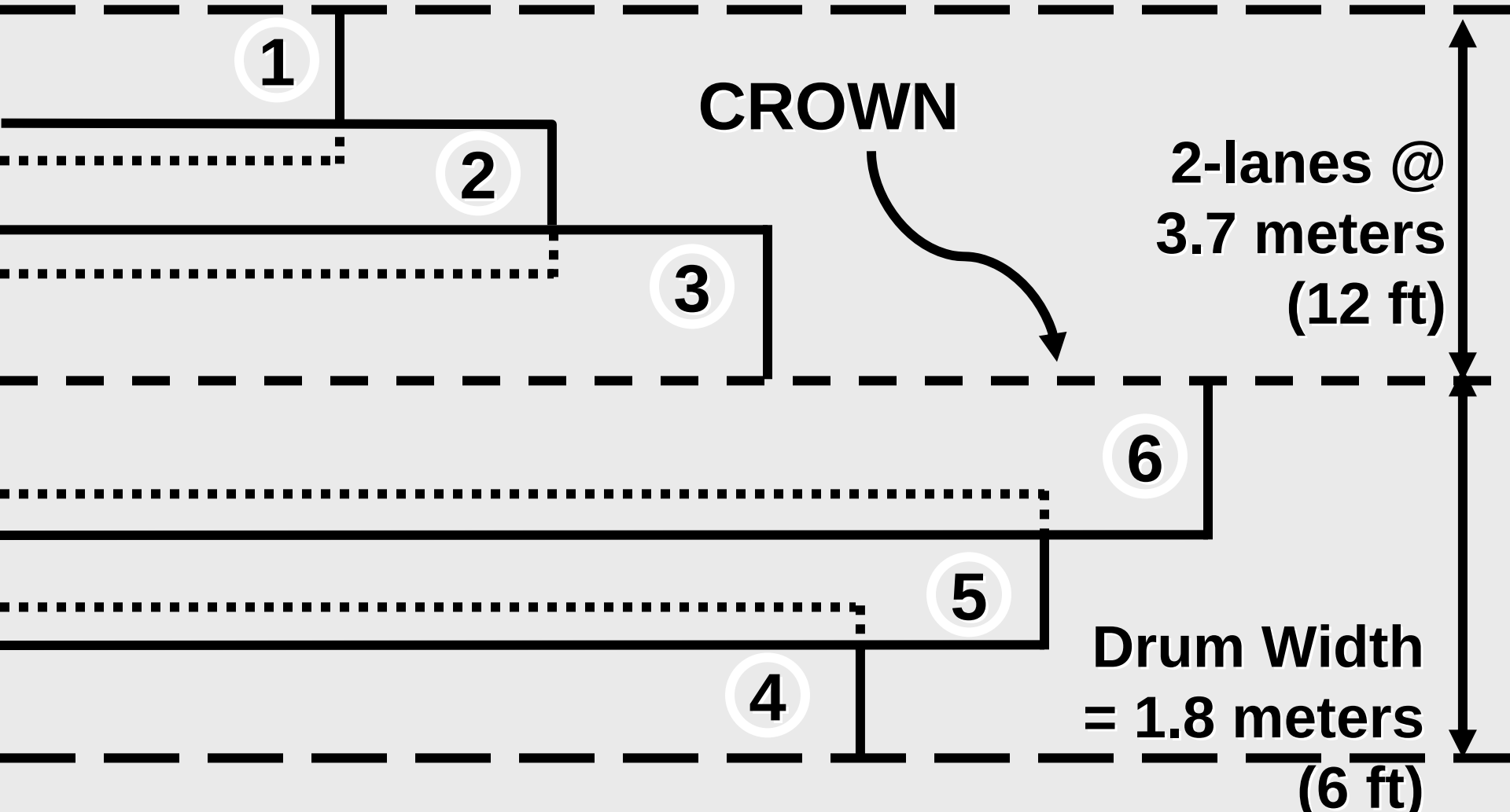
- Selecting Compaction Equipment
- Width of Paving
- Width of Roller
- Number of Coverages Needed
- Nuclear Gauge

Roller Widths

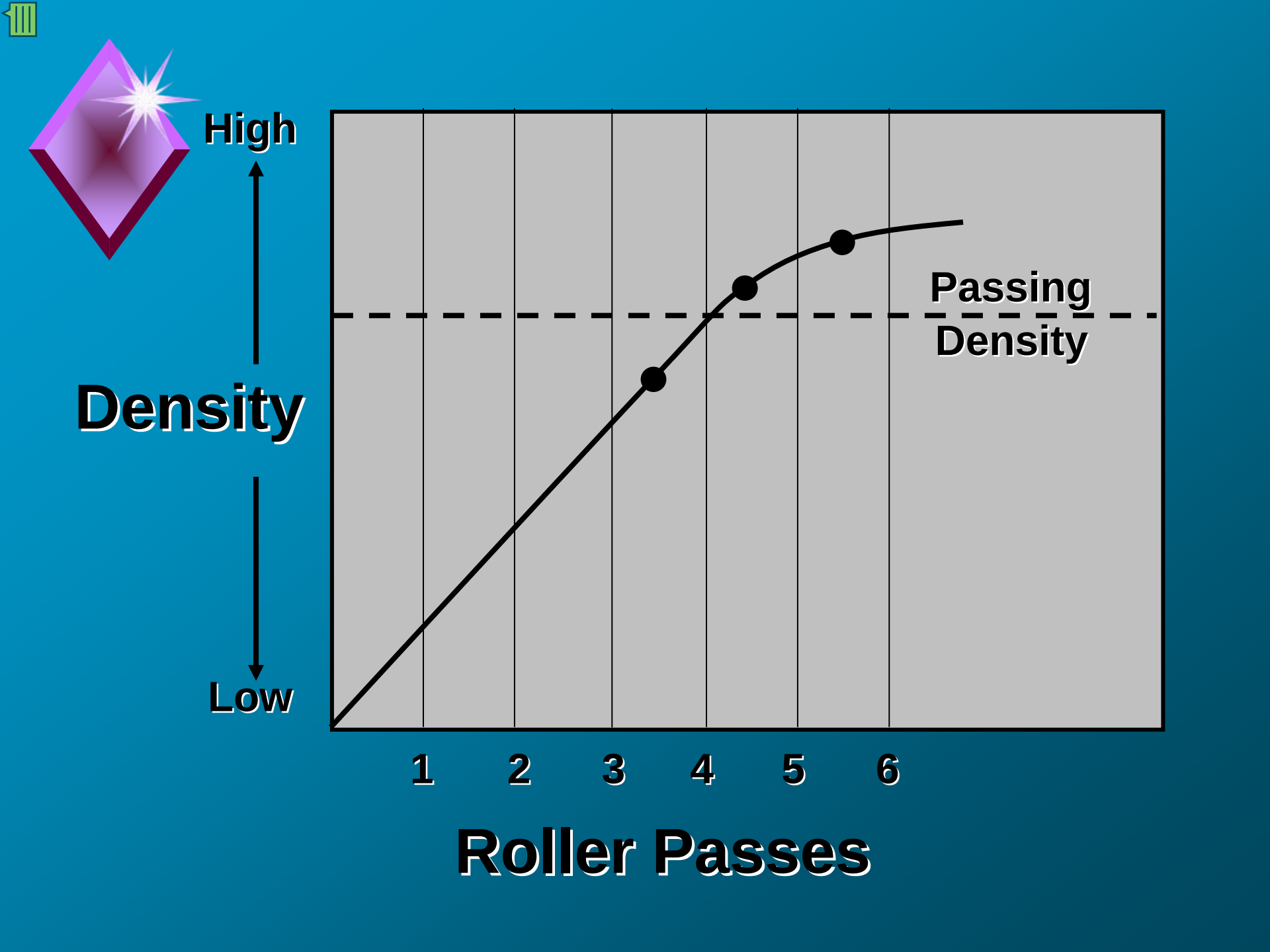
Courtesy of Caterpillar Paving Products

Paving Widths

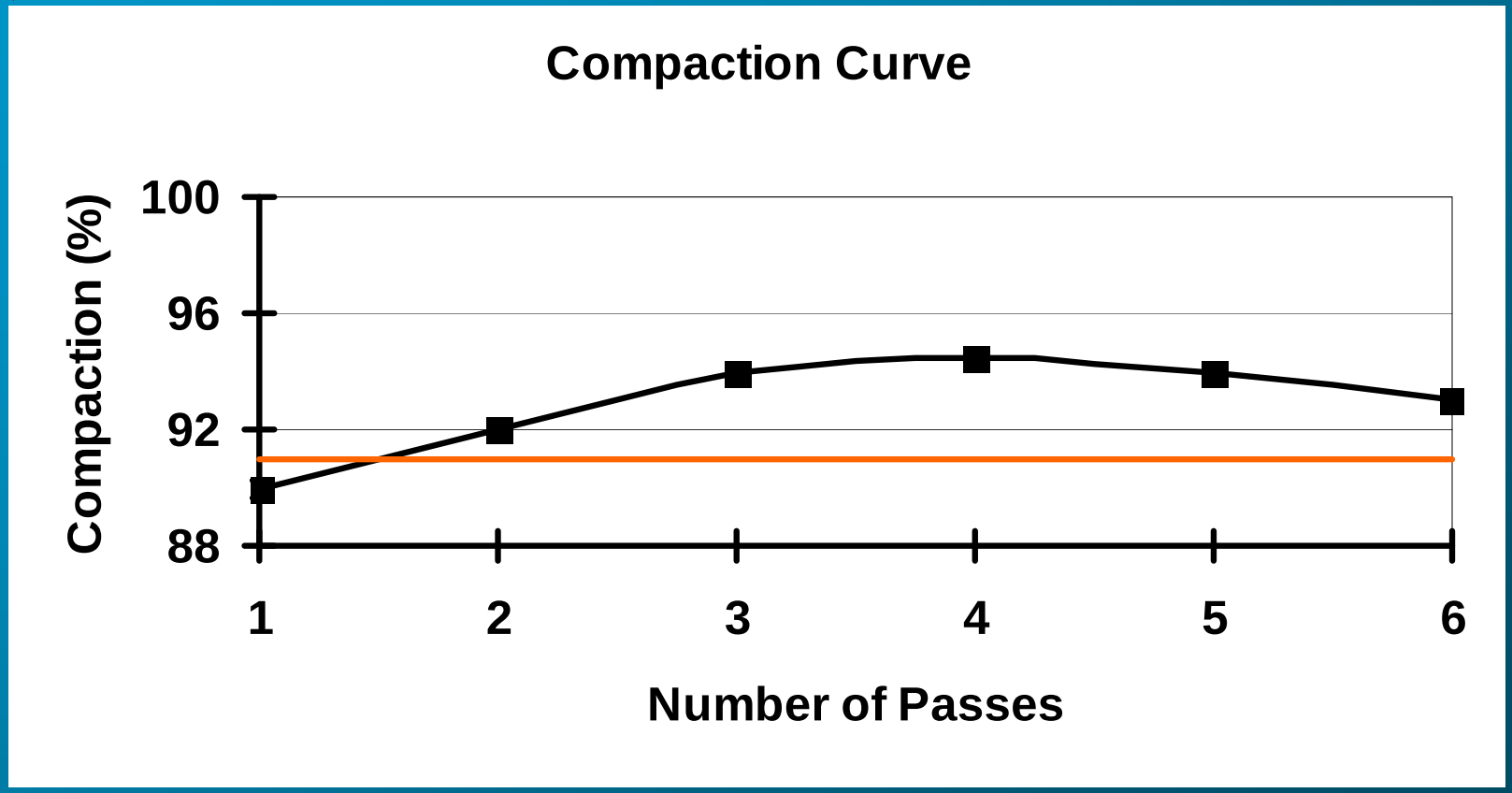
One Roller Coverage



How Many Repeat Coverages to Assure Density?

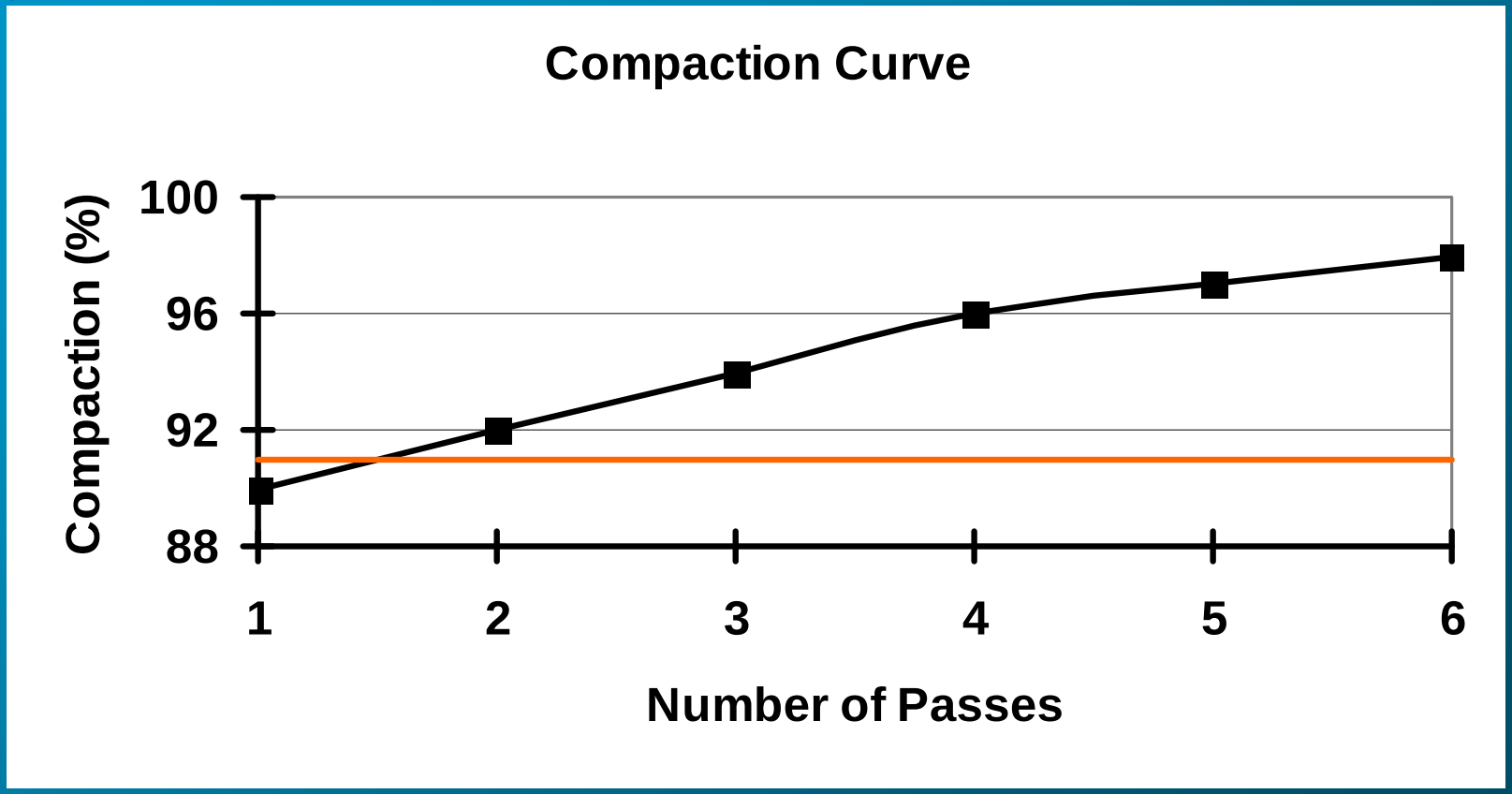

High
Density
Low
Passing
Density
1
2
3
4
5
6
Roller Passes

Roller Pattern Problem #1



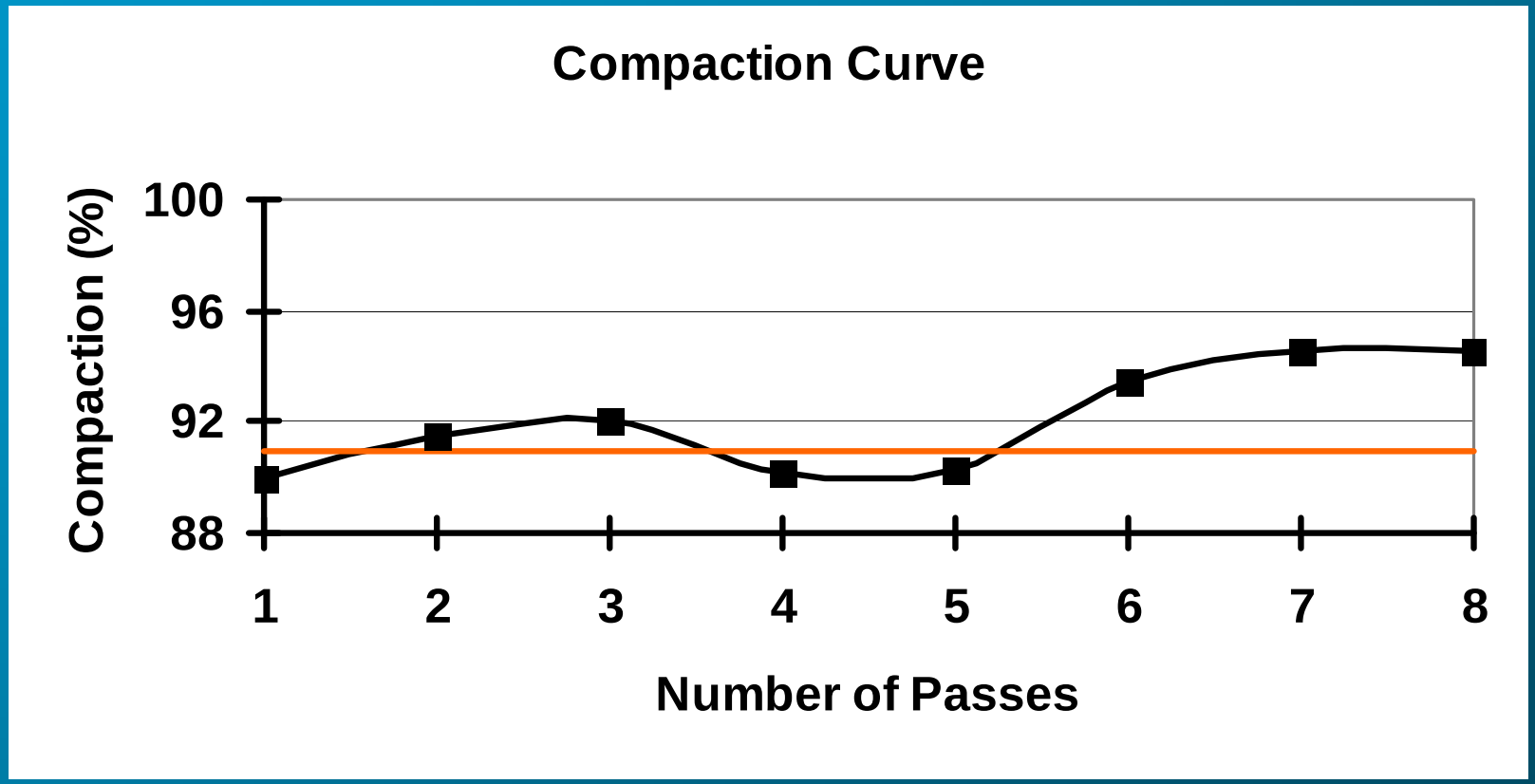
Decreasing Temperature

Roller Pattern Problem #2



Decreasing Temperature

Roller Pattern Problem #3



Decreasing Temperature

Thermometers

- Types
- Uses
- Potential problems
- Calibrating
- Actually using one

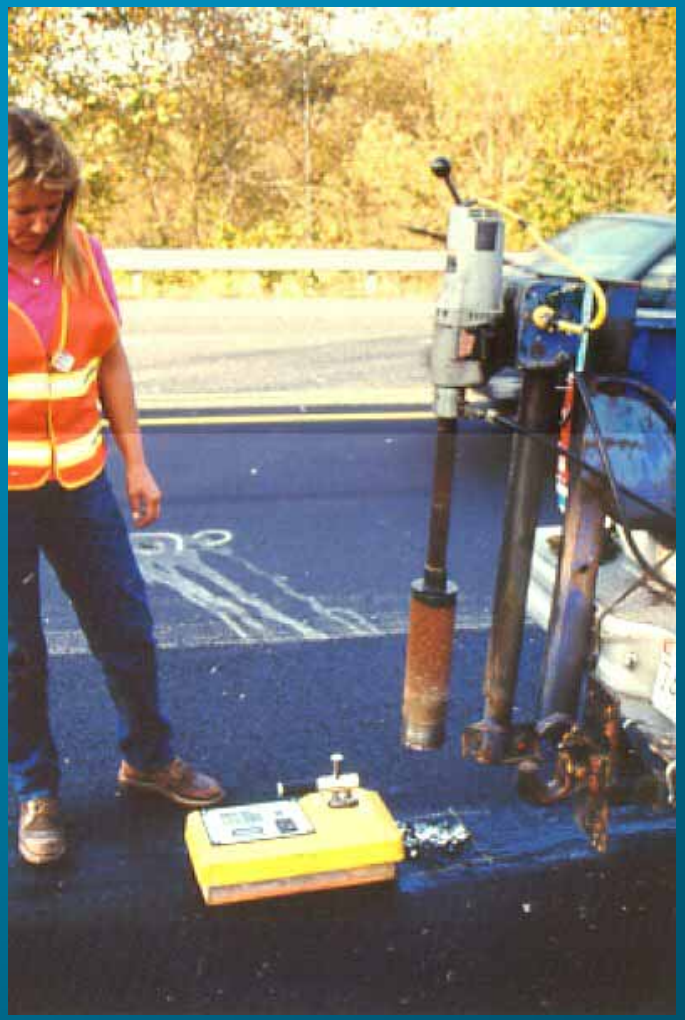
Temperature Gauges

Checking Density

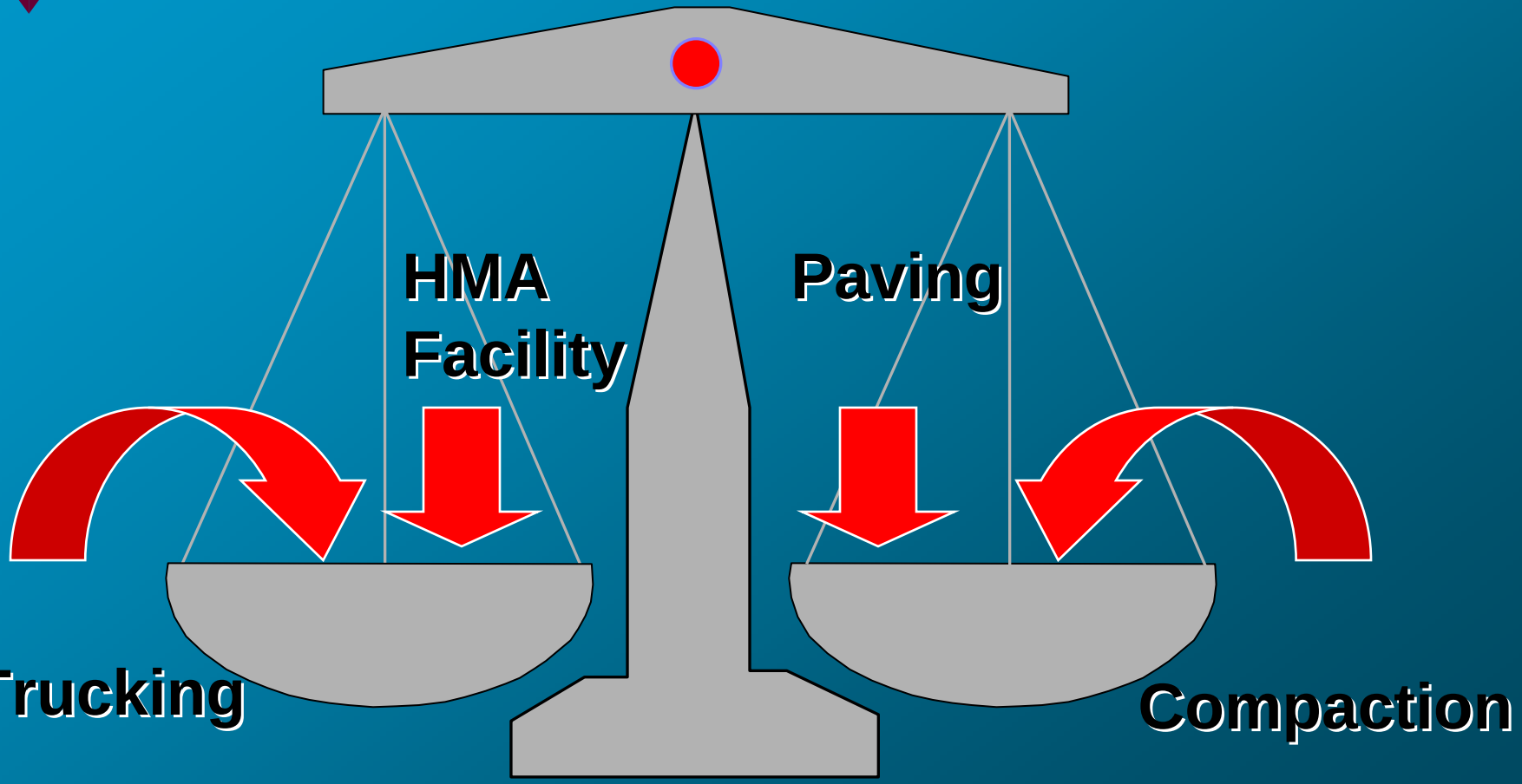
Finish Rolling

Courtesy of Caterpillar Paving Products

Coring



Balancing Production



Questions???